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ON THE ASSOCIATION OF GROSSULARITE, ZOISITE, HEULANDITE, AND LEIDYITE—A NEW SPECIES.

BY PROFESSOR GEORGE A. KÖNIG.

On Crum Creek, just above Chester, Delaware County, Pennsylvania, the gneiss formation has been kept opened for many years by the quarries of Messrs. Deshong. The gneiss shows here a granitoid structure, with just enough of mica to produce a very straight fracture, combining thus the toughness of granite with the easier workability of the gneiss. The stratification strikes nearly north and south, while the dip is almost vertical. Seams of coarse-grained granite are frequent in the granitoid gneiss, carrying, occasionally, crystals of Orthoclose, black Tourmaline, and Beryl of unusual size and beauty. In the eastern part of the quarry, the structure of the gneiss is schistose, in fact, the rock is more properly called mica schist, the feldspathic element receding considerably. This rock is interstratified with seams of gray quartz, and in blasting one of these seams recently, near the foot of the cliff, which is here about forty feet high, Mr. A. O. Deshong observed minerals, the like of which the quarry had never produced before. I am much indebted to Mr. Deshong's liberality, who placed this entire material in my hands. Through the falling of top rock the spot is now covered; but it will be reopened in the spring, and more materials of interest may be expected by mineralogists. Some of the specimens have a very pleasing appearance through the contrast of the green, brownish-yellow, and rose color of the associated minerals.

1. *Grossularite. a. Yellow Variety.*—In well-defined crystals, some two centimetres and more in diameter. Form chiefly the rhombic dodecahedron, ∞ O in combination with 2O2. One crystal entirely embedded in quartz is elongated, and easily mistaken for a tetragonal form. Mostly granular massive. Color from brownish- to amber-yellow. Lustre vitreous; fatty on the fracture. Transparent. H = 6. Spec. gr. = 3.637 at 20° C.

Chemical Characters.—The mineral fuses at 3 to a brownish or slightly greenish glass. With soda and borax in O.Fl manganese reaction. Not acted upon by hydrochloric acid, either before or after ignition. The white powder turns straw-color when ignited.

				Quotient.	
SiO_2	= 39.80	Si	= 18.53	0.662	0.662
Al_2O_3	= 21.16	$\dot{Al}$	= 11.29	0.206	0.225
Fe_2O_3	= 3.14	$\dot{Fe}$	= 2.19	0.019	
FeO	= 0.72	Fe	= 0.56	0.010	0.642
MnO	= 1.80	Mn	= 1.39	0.025	
CaO	= 34.00	Ca	= 24.29	0.607	
MgO	= trace				
Ignition	= none				
	100.62				

These quotients furnish the ratio:—

$$Si : \dot{Al} : Ca = 2.940 : 1.00 : 2.853.$$

Or

$$Ca_3 \dot{Al} Si_3 O_{12}.$$

b. Greenish Variety.—Not observed in crystals. Massive granular. Color light grass-green to nearly white, the two varieties seem to pass into one another. I observed some striated planes, and thought they might belong to the following species of Zoisite, but fragments placed in the flame did not show intumescence, and fused like the yellow variety. Lustre on fracture less fatty than in the yellow variety. Highly transparent. $H = 6$. Spec. gr. 3.238.

Chemical Characters.—Fuses at 3, and with the fluxes gives strong manganese reaction. Not materially attacked by hydrochloric acid either before or after ignition.

Composition according to an analysis made by my assistant, Mr. R. B. Chipman.

			Quotient.	
SiO_2	= 39.08	Si	= 0.6504	0.6504
Al_2O_3	= 23.26	$\dot{Al}$	= 0.2248	0.2298
Fe_2O_3	= .80	$\dot{Fe}$	= 0.0050	
FeO	= .86	Fe	= 0.0119	0.6279
MnO	= 7.60	Mn	= 0.1071	
CaO	= 28.50	Ca	= 0.5089	
Ignition	= 0.32			
	100.52			

Ratio:—

$$Ca : \dot{Al} : Si = : 2.733 : 1.00 : 2.834.$$

If the iron were all ferrous the ratio would become very nearly 3 : 1 : 3, as in the preceding variety, and it seems highly probable that such is the case, considering the difficulty in the way of a correct determination of ferrous iron in this instance, and the small quantities involved. Neither of these varieties has been identified in the United States by analysis.

Andradite and Pyrope are the usual varieties known in the American gneiss formation.

2. *Zoisite.*—Massive, cryptocrystalline, and in aggregation of small prismatic crystals. In the latter condition the specimen is friable between the fingers, as the individual crystals are but loosely cemented together. The shape of the crystals resembles very much that of Pyroxene. The striations on the prismatic faces are not noticeable; but an oblique cleavage seems to be present. I could not obtain satisfactory measurement. The prismatic angle was found approximately = 107°. The prism was terminated in one crystal by two brachydomes too small for measurement.

Color rose-red to pale pink. Strong vitreous lustre. H = 6 Spec. gr. = 3.642

Chemical Characters.—Swells up in the O.Fl, and fuses at 4 to 4.5 to a white enamel. With soda and borax in O.Fl manganese reaction. Not acted upon by hydrochloric acid either before or after ignition. When heated in the closed tube the rose-color disappears, and the mineral seems gray, yielding a small quantity of water. Upon cooling, the rose-color reappears with its former intensity.

The mean of two closely-agreeing analyses gave me:—

				Quotient.	
SiO_2	= 40.70	Si	= 19.00	0.679	0.679
Al_2O_3	= 33.30	Ⱥl	= 17.78	0.326	0.341
Fe_2O_3	= 2.40	Ꞙe	= 1.68	0.015	
FeO	= 0.70	Fe	= 0.57	0.100	0.366
MnO	= 0.43	Mn	= 0.307	0.005	
CaO	= 19.70	Ca	= 14.06	0.351	
MgO	= 0.15				
Ignition	= 2.40	H_2O	= 2.40	0.12	
	99.78				

Producing the ratio:—

R : Ⱥl : Si = 1.07 : 1.00 : 1.991.

Or,

$$\text{Ca Al Si}_2\text{ O}_8.$$

And taking the water into consideration we obtain:—

$$(\text{Ca Ⱥl Si}_2\text{ O}_8)_3 + H_2O.$$

Is the water essential in the composition of Zoisite? Rammelsberg does not consider it so; and yet all analyses of this mineral show its presence. To me it seems to be essential, as I connect it with the remarkably distinct intumescence of Zoisite. Intumescence surely is caused by the escape of gas or vapor while the substance is in a semi-fluid state; it is but another form of exfoliation.

Minerals, with eminent basal cleavage and water of hydration or of crystallization, exfoliate, as the vermiculites, and to a lesser degree Heulandite; minerals possessing less cleavage, or none at all, exhibit intumescence. This phenomenon, as yet unexplained, is quite worthy of a thorough investigation.

It is possible, that in this, as also in other instances, a hydrated product of alteration is interlaminated with the really anhydrous mineral, thus producing apparent intumescence of the whole. This is merely a suggestion.

3. *Heulandite.*—This Zeolite occurs in cavities or upon either the Garnet or the Zoisite, in the usual form and combinations. A sufficient quantity for analysis could not be collected, but the pyrognostic characters were found to be those of heulandite. It has an olive-green color, probably from an admixture of the following mineral. It is evidently a product of alteration.

4. *Leidyite.*—On the quartz, but particularly on the Garnet and Zoisite, I found a mineral substance having the following characters: Not crystallized, but probably crystalline, massive in small lumps, or as a thin botryoidal incrustation. In the cavities it forms delicate stalactites, and leaf-shaped films pending from the sides. It is very soft ($H = 1$) Touch unctuous, lustre waxy. Color fine grass-green, olive-green, and greenish-gray, sometimes a bluish-green. Streak white. When crushed in the mortar, takes a silky lustre, as it parts into fine white scales.

Chemical Characters.—In O.Fl swells up and boils, fusing at 4 to a light yellowish-green glass. Reacts for iron, and slightly for manganese with soda and borax. Heated in closed tube yields water and turns yellowish-brown. Dissolves readily in strong *cold* hydrochloric acid. The solution precipitates auric chloride (ferrous iron). Not soluble after ignition. I was able to collect a little over two decigrams of critically pure material from the largest stalactite. The analysis gave—

			Quotient.	
SiO_2 = 51.40		Si = 23.94	0.855	
Al_2O_3 = 16.82		$\bar{\mathrm{A}}\mathrm{l}$ = 9.51	0.173	0.173
FeO = 8.50		Fe = 6.61	0.118	0.248
CaO = 3.15		Ca = 2.19	0.054	
MgO = 3.07		Mg = 1.84	0.076	
H_2O = 17.08				
100.03				

This gives the ratio for

$$R^{ii} : R^{vi} : Si = 1.43 : 1.00 : 4.942.$$
$$= 1.5 : 2 : 5.$$

This corresponds to the oxygen ratio

$$4\tfrac{1}{2} : 10.$$

But it is much more probable that one atom of hydrogen enters into the molecular equivalent to $\frac{1}{2}$ atom R^{ii}, producing thus a saturated bisilicate.

The mineral has then the general formula

$$R^{ii}_2\ \bar{\mathrm{A}}\mathrm{l}\ Si_5\ O_{15} + 5H_2O.$$
$$R^{ii}_2 = \tfrac{7}{20}Fe + \tfrac{3}{20}Ca + \tfrac{5}{20}Mg + \tfrac{5}{20}H.$$

I place this mineral in the system with the bisilicate Zeolites for these reasons:—

1. Similar behavior before the blowpipe.
2. Association and like origin.
3. Similarity of chemical composition, particularly with Heulandite. Both minerals are formed by metamorphosis of Grossularite and Zoisite.

Named after the distinguished comparative anatomist, Dr. Joseph Leidy, of Philadelphia.